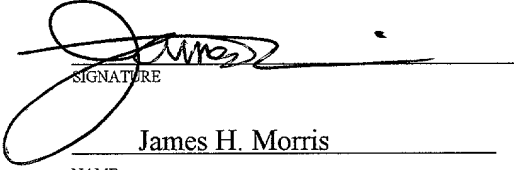


FORM PTO-1390 (REV. 10-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER S1022/8668
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371			U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/856438
INTERNATIONAL APPLICATION NO. PCT/SE99/02116	INTERNATIONAL FILING DATE 18 November 1999	PRIORITY DATE CLAIMED 21 November 1998 5 March 1999	
TITLE OF INVENTION IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS			
APPLICANT(S) FOR DO/EO/US SJÖBERG, Franck, WILSON, Sarah Kate, NILSSON, Rikard, BENGTSSON, Daniel, ISAKSSON, Mikael, NORDSTROM, Tomas, ÖDLING, Per, BAHLENBERG, Gunnar, JOHANSSON, Magnus, OLSSON Lennart, OKVIST, Sven-Göran			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<ol style="list-style-type: none"> 1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input type="checkbox"/> This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)). 4. <input type="checkbox"/> The US has been elected by the expiration of 19 months from the earliest claimed priority date (PCT Article 31). 5. <input type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)). <ol style="list-style-type: none"> a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> has been transmitted by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). <ol style="list-style-type: none"> a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> has been transmitted by the International Bureau. 7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)). <ol style="list-style-type: none"> a. <input type="checkbox"/> are attached hereto (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(C)(5)). 			
Items 11. To 16. Below concern document(s) or information included:			
11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.			
12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included			
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment.			
14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.			
15. <input type="checkbox"/> A substitute specification.			
16. <input type="checkbox"/> A change of power of attorney and/or address letter.			
17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.			
18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).			
19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).			
20. <input checked="" type="checkbox"/> Other items or information: Title page of WO 00/31890			
Express Mail Label No. EL840396842US Date Mailed: May 21, 2001			

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)		INTERNATIONAL APPLICATION		ATTORNEY'S DOCKET NUMBER	
09/856438		PCT/SE99/02116		S1022/8668	
21. <input checked="" type="checkbox"/> The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but but international search fee paid to USPTO (37 CFR 1.445(a)(2)), paid to USPTO \$710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) But all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT = \$860.00					
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	23 - 20 =	3	X \$18.00	\$	54.00
Independent Claims	3 - 3 =		X \$80.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+\$270.00	\$	
PETITION TO REVIVE FEE				\$	
TOTAL OF ABOVE CALCULATIONS				=	\$ 914.00
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$	
SUBTOTAL				=	\$
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE				=	\$ 914.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate coversheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$	40.00
TOTAL FEES ENCLOSED				=	\$ 954.00
				Amount to be:	\$
				refunded	
				charged	\$
a. <input checked="" type="checkbox"/> A check in the amount of \$954.00 to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ In the amount of \$_____ To cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23/2825 A duplicate of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO					
WOLF, GREENFIELD & SACKS, P.C. 600 Atlantic Avenue Boston, Massachusetts 02210 Tel: (617) 720-3500					
SIGNATURE  NAME <u>James H. Morris</u>					
REGISTRATION NO <u>34,681</u>					
CUSTOMER NUMBER 23628					

09/ 856438

JC03 Rec'd PCT/PTC 21 MAY 2001

Express Mail Label No. EL840396842US
Attorney's Docket No. S1022/8668
Date Mailed: May 21, 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: SJÖBERG, Franck, WILSON, Sarah Kate, NILSSON, Rikard, BENGTTSSON, Daniel,
ISAKSSON, Mikael, NORDSTROM, Tomas, ÖDLING, Per, BAHLENBERG, Gunnar,
JOHANSSON, Magnus, OLSSON Lennart, OKVIST, Sven-Göran

Serial No.: Unassigned

Filing Date: Herewith

For: IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

Examiner: Unassigned

Art Unit: Unassigned

Commissioner for Patents
Box Patent Application (DO/EO/US)
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir/Madam:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

On page 1, after the title, insert and center--Background of the Invention--;

On page 1, before line 2, insert --1. Field of the Invention--;

On page 1, before line 6, insert --2. Discussion of the Related Art--;

On page 1, before line 12, insert --Summary Of The Invention--;

On page 6, before line 3, insert --Brief Description Of The Drawings--;

On page 6, before line 6, insert --Detailed Description--;

On page 8, after line 10, insert the following paragraphs:

-- Having thus described at least one illustrative embodiment of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended as limiting. The invention is limited only as defined in the following claims and the equivalents thereto.

What is claimed is:--;

IN THE CLAIMS

1. (Amended) A very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, wherein modems on relatively short wires have control means for reducing their transmit power so that far end cross talk produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

2. (Amended) A very high rate digital subscriber line system, as claimed in claim 1, wherein said relatively short wires are less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

3. (Amended) A very high rate digital subscriber line system, as claimed in claim 1 wherein said control means are adapted to distribute power over an available frequency band so that said target bit rate is achieved.

4. (Amended) A very high rate digital subscriber line system, as claimed in claim 1 wherein said system is adapted to modulate transmitted data using discrete multitone.

5. (Amended) A very high rate digital subscriber line system, as claimed in claim 1, wherein the control means, associated with a given modem connected to a given wire, is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the [far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k) \Gamma_M} \right)$$

where $Fext_k$ is a far end cross talk from other very high rate digital subscriber line modems, Γ is a signal to noise ratio-gap, Γ_m is a system margin and R is a target bit rate per discrete multitone frame.

6. (Amended) A very high rate digital subscriber line system, as claimed in 5, wherein said far end cross talk transfer function is given by:

$$F_k = K \int_0^d |H_k|^2 d$$

where H_k is a transfer function for a given wire, f_k is a frequency for subcarrier k , d is the length of wire and K is a constant.

7. (Amended) A very high rate digital subscriber line system, as claimed in claim 5, wherein E_k is always less than a maximal allowable power spectral density-level, PSD_{max} for said very high rate digital subscriber line system.

8. (Amended) A very high rate digital subscriber line system, as claimed in claim 7, wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{max}$$

and

$$E_k = PSD_{max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{max}$$

9. (Amended) A modem for use with a very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate wherein said modem has control means for reducing its transmit power so that far end cross talk produced by said modem is reduced.

10. (Amended) A modem, as claimed in claim 9, wherein said control means is adapted to distribute power over an available frequency band so that said target bit rate is achieved.

11. (Amended) A modem, as claimed in claim 9, wherein said modem is adapted to modulate transmitted data using discrete multitone.

12. (Amended) A modem, as claimed in claim 9 wherein said modem is connected to a wire, and in that said control means is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is [the] a background noise on sub-carrier k , F_k is a far end cross talk transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k) \Gamma_M} \right)$$

where $Fext_k$ is a far end cross talk from other very high rate digital subscriber line modems, Γ is a signal to noise ratio-gap, Γ_m is a system margin and R is a target bit rate per discrete multitone frame.

13. (Amended) A modem, as claimed in claim 12, wherein said far end cross talk transfer function is given by:

$$F_k - K \int_k^2 H_k^2 d$$

where H_k is a transfer function for the given wire, f_k is a frequency for subcarrier k , d is a length of the wire and K is a constant.

14. (Amended) A modem, as claimed in claim 12, wherein E_k is always less than a maximal allowable power spectral density-level for very high rate digital subscriber line.

15. (Amended) A modem, as claimed in claim 14, wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

16. (Amended) In a very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, including reducing the transmit power of modems on relatively short wires so that far end cross talk produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

17. (Amended) A method as claimed in claim 16, including said relatively short wires being less than 1,000 metres long, and by said substantially longer wires being more than 1,000 metres long.

18. (Amended) A method as claimed in claim 16, including distributing power over an available frequency band so that said target bit rate is achieved.

19. (Amended) A method, as claimed in claim 16, including modulating transmitted data using discrete multitone.

20. (Amended) A method as claimed in claim 15, whereby producing an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k) \Gamma_M} \right)$$

where $Fext_k$ is a far end cross talk from other very high rate digital subscriber line modems, Γ is a signal to noise ratio -gap, Γ_m is a system margin and R is a target bit rate per discrete multitone frame.

21. (Amended) A method, as claimed in claim 20, wherein said far end cross talk transfer function being given by:

$$F_k = K \cdot |H_k|^2 \int_k^2 d$$

where H_k is a transfer function for the given wire, f_k is a frequency for sub-carrier k , d is a length of the wire and K is a constant.

22. (Amended) A method, as claimed in either claim 20, or 21, wherein E_k always less than a maximal allowable power spectral density-level, PSD_{max} for said very high rate digital subscriber line system.

23. (Amended) A method, as claimed in claim 22, wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k - PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

REMARKS

This is a preliminary amendment in which the claims have been amended to place them in better form before initial examination by the Examiner. Favorable action is hereby earnestly solicited.

Respectfully submitted,

By: 

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Attorney's Docket No. S1022/8668

Dated: May 21, 2001

AMENDED CLAIMS SHOWING THE AMENDMENTS

1. (Amended) A [VDSL] very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, [characterised in that] wherein modems on relatively short wires have control means for reducing their transmit power so that [FEXT] far end cross talk produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

2. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 1, [characterised in that] wherein said relatively short wires are less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

3. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 1[, or claim 2, characterised in that] wherein said control means are adapted to distribute power over an available frequency band so that said target bit rate is achieved.

4. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 1 [any previous claim, characterised in that] wherein said system is adapted to modulate transmitted data using [DMT] discrete multitone.

5. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in [any previous claim] claim 1, [characterised in that] wherein the control means, associated with a given modem connected to a given wire, is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the [FEXT] far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k) \Gamma_M} \right)$$

where $Fext_k$ is [the FEXT] a far end cross talk from other [VDSL] very high rate digital subscriber line modems, Γ is [the] a [SNR] signal to noise ratio-gap, Γ_m is [the] a system margin and R is [the] a target bit rate per [DMT] discrete multitone frame.

6. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in 5, [characterised in that] wherein said [FEXT] far end cross talk transfer function is given by:

$$F_k = K \setminus H_k \setminus^2 \int_k^2 d$$

where H_k is [the] a transfer function for [the] a given wire, f_k is [the] a frequency for subcarrier k , d is the length of wire and K is a constant.

7. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in [either] claim 5, [or 6, characterised in that] wherein E_k is always less than a maximal allowable [PSD] power spectral density-level, PSD_{\max} for said [VDSL] very high rate digital subscriber line system.

8. (Amended) A [VDSL] very high rate digital subscriber line system, as claimed in claim 7, [characterised in that] wherein: $E_k = \lambda \frac{n_k}{F_k}$ for $\lambda \frac{n_k}{F_k} < PSD_{\max}$

and

$$E_k - PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

9. (Amended) A modem for use with a [VDSL] very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate, [characterised in that] wherein said modem has control means for reducing its transmit power so that [FEXT] far end cross talk produced by said modem is reduced.

10. (Amended) A modem, as claimed in claim 9, [characterised in that] wherein said control means is adapted to distribute power over an available frequency band so that said target bit rate is achieved.

11. (Amended) A modem, as claimed in [either] claim 9, [or 10, characterised in that] wherein said modem is adapted to modulate transmitted data using [DMT] discrete multitone.

12. (Amended) A modem, as claimed in claim 9 [any of claims 9 to 11, characterised in that] wherein said modem is connected to a wire, and in that said control means is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is [the] a background noise on sub-carrier k , F_k is [the FEXT] a far end cross talk transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k) \Gamma_M} \right)$$

where F_{ext_k} is [the FEXT] a far end cross talk from other [VDSL] very high rate digital subscriber line modems, Γ is [the] a [SNR] signal to noise ratio-gap, Γ_m is [the] a system margin and R is [the] a target bit rate per [DMT] discrete multitone frame.

13. (Amended) A modem, as claimed in claim 12, [characterised in that] wherein said [FEXT] far end cross talk transfer function is given by:

$$F_k = K \setminus H_k \setminus^2 \int_k^2 d$$

where H_k is [the] a transfer function for the given wire, f_k is [the] a frequency for subcarrier k , d is [the] a length of the wire and K is a constant.

14. (Amended) A modem, as claimed in [either] claim 12, [or 13, characterised in that] wherein E_k is always less than a maximal allowable [PSD] power spectral density-level for [VDSL] very high rate digital subscriber line.

15. (Amended) A modem, as claimed in claim 14, [characterised in that] wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

16. (Amended) In a [VDSL] very high rate digital subscriber line transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, [characterised by] including reducing the transmit power of modems on relatively short wires so that [FEXT] far end cross talk

produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

17. (Amended) A method as claimed in claim [15] 16, [characterised by] including said relatively short wires being less than 1,000 metres long, and by said substantially longer wires being more than 1,000 metres long.

18. (Amended) A method as claimed in [either] claim 16, [or claim 17, characterised by] including distributing power over an available frequency band so that said target bit rate is achieved.

19. (Amended) A method, as claimed in [any of claims 16, to 18, characterised by] claim 16, including modulating transmitted data using [DMT] discrete multitone.

20. (Amended) A method as claimed in [any of claims 15 to 19, characterised by] claim 15, whereby producing an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the [FEXT] far end cross talk transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + Fext_k) \Gamma_M} \right)$$

where $Fext_k$ is [the FEXT] a far end cross talk from other [VDSL] very high rate digital subscriber line modems, Γ is [the] a [SNR] signal to noise ratio-gap, Γ_m is [the] a system margin and R is [the] a target bit rate per [DMT] discrete multitone frame.

21. (Amended) A method, as claimed in claim 20, [characterised by] wherein said [FEXT] far end cross talk transfer function being given by:

$$F_k - K |H_k|^2 \int_k^2 d$$

where H_k is [the] a transfer function for the given wire, f_k is [the] a frequency for sub-carrier k , d is [the] a length of the wire and K is a constant.

22. (Amended) A method, as claimed in either claim 20, or 21, [characterised by] wherein E_k always less than a maximal allowable [PSD] power spectral density-level, PSD_{\max} for said [VDSL] very high rate digital subscriber line system.

23. (Amended) A method, as claimed in claim 22, [characterised by] wherein:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

Improvements in, or Relating to, VDSL Transmission Systems

The present invention relates to a VDSL transmission system in which power control is used to reduce FEXT, a modem for use in a VDSL transmission system, and a method of reducing FEXT in a VDSL transmission system by using power back-off.

One problem, frequently encountered with VDSL transmission systems, is that upstream FEXT produced by system users having short wires can be very strong. This severely limits the performance for users with longer wires. Users having shorter wires get high bit rates whereas users having longer wires get low bit rates, or possibly a zero bit rate. In extreme cases it may happen that users with wire lengths greater than 1000 metre cannot transmit data upstream.

The present invention provides a way of overcoming this problem by using power back-off to provide a more even distribution of the available bandwidth capacity among customers with different wire lengths. Power back-off means that modems on shorter wires reduce their transmit power in order to lower the FEXT they produce. This enables modems on longer wires to obtain an acceptable bit rate.

Known techniques for reducing FEXT cannot set target bit rates for the users and cannot provide any sort of optimisation of bit rate distribution between users. The present invention gives a better performance, i.e. higher bit rates, than known techniques for reducing FEXT, especially for thinner, i.e. more lossy, wires.

According to a first aspect of the present invention, there is provided a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, characterised in that modems on relatively short wires have control means for reducing their transmit power so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

- 2 -

Said relatively short wires may be less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.

At least some of said modems may have control means adapted to distribute power over an available frequency band so that said target bit rate is achieved.

Said VDSL system may be adapted to modulate transmitted data using DMT.

The control means, associated with a given modem connected to a given wire, may be adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the FEXT transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + \text{Fext}_k) \Gamma_M} \right)$$

where Fext_k is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

Said FEXT transfer function may be given by:

$$F_k = K |H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k , d is the length of the wire and K is a constant.

E_k may always be less than a maximal allowable PSD-level, PSD_{max} , for said VDSL system.

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E_k may be given by:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for } \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for } \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

According to a second aspect of the present invention, there is provided a modem for use with a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate, characterised in that said modem has control means for reducing its transmit power so that FEXT produced by said modem is reduced.

Said control means may be adapted to distribute power over an available frequency band so that said target bit rate is achieved.

Said modem may be adapted to modulate transmitted data using DMT.

Said modem may be connected to a wire, and said control means may be adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the FEXT transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + F_{ext_k}) \Gamma_M} \right)$$

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where $F_{ext,k}$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

Said FEXT transfer function may be given by:

$$F_k = K |H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k , d is the length of the wire and K is a constant.

E_k may always be less than a maximal allowable PSD-level for VDSL.

E_k may be given by:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for } \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for } \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

According to a third aspect of the present invention, there is provided, in a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, characterised by reducing the transmit power of modems on relatively short wires so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

Said relatively short wires may be less than 1,000 metres long and said substantially longer wires may be more than 1,000 metres long.

Power may be distributed over an available frequency band so that said

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target bit rate is achieved.

Transmitted data may be modulated using DMT.

An energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the FEXT transfer function for said given wire and λ is a constant which is adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + \text{Fext}_k) \Gamma_M} \right)$$

where Fext_k is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame, may be produced.

Said FEXT transfer function may be given by:

$$F_k = K |H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for sub-carrier k , d is the length of the wire and K is a constant.

E_k may always be less than a maximal allowable PSD-level, PSD_{\max} , for said VDSL system.

E_k may be given by:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < \text{PSD}_{\max}$$

and

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$$E_k = PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a telephone access network in which the present invention may be implemented.

Figure 2 illustrates the way in which PSD varies for different wire lengths.

A glossary of the abbreviations used in this patent specification is set out below to aid the reader:

DMT:	Discrete Multi Tone
FEXT:	Far-End Cross Talk
PSD:	Power Spectral Density
SNR:	Signal to Noise Ratio
VDSL:	Very high rate Digital Subscriber Line

A typical telephone access network, suitable for use with a VDSL transmission system is shown in Figure 1. It will be seen that network terminals, NT, are located at a variety of distances from the central station, typically between 300m and 1,500m. Because of the FEXT produced by network terminals located close to the central station, the more remote terminals, further than 1,000m from the central station, may have little useable bandwidth available to them, i.e. they will only be able to transmit data in the upstream direction at low bit rates.

The present invention provides a method of performing power back-off in a VDSL modem, which may be located in any of the network terminals shown in

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Figure 1. Consider a VDSL modem operating in the access network of Figure 1, on a wire of a given length, where several other modems operate on wires of different lengths. Some of the wire lengths may be longer and others may be shorter and yet others of the same length. The modem has a target bit rate assigned to it and the power is distributed over the frequency band in such a manner that the target bit rate can be achieved. The power distribution is made in such a way that the bit rates of other modems, connected to the same access network, are maximised.

Consider, as an example, a VDSL system employing DMT and let E_k denote the transmit energy to be used on sub-carrier k . If a target bit rate of R bits per DMT frame is to be achieved, the following constraint on the energies E_k exist:

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + F_{ext_k})\Gamma_M} \right) \quad (1)$$

where n_k is the background noise on sub-carrier k , F_{ext_k} is the FEXT from other VDSL modems, Γ is the SNR - gap (≈ 9.8 dB), Γ_m is the system margin (typically 3 - 6dB). To maximise the bit rate for the other VDSL modems, the energy on the k^{th} sub-carrier should be:

$$E_k = \lambda \frac{n_k}{F_k} \quad (2)$$

where λ is a constant that is adjusted so that equation (1) is fulfilled, and F_k is the FEXT transfer function for the wire under consideration. The FEXT transfer function can be calculated from:

$$F_k = K |H_k|^2 f_k^2 d \quad (3)$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k , d is the length of the wire and K is a constant. K and d are of no great importance since they are subsumed in λ . By using equation (2) to set the energy distribution, the FEXT will be spectrally shaped in the same way as the background noise.

Another constraint, that must always be applied, is that E_k must never exceed the maximum allowable PSD-level for VDSL, i.e. PSD_{\max} . This means that equation (2) can be rewritten as:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for } \lambda \frac{n_k}{F_k} < PSD_{\max}$$

$$E_k = PSD_{\max} \quad \text{for } \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

If too large a value of R is chosen, then it may happen that $E_k = PSD_{\max}$ for all k without achieving the target bit rate.

Figure 2 shows an example of how the PSD looks for different wire lengths. Shorter wires use lower transmit powers and tend to load more power on the higher frequencies than on the lower frequencies. Since the longer wires can only use the lower frequencies, it seems intuitive to let the short wires use the higher frequencies and save the lower frequencies for the longer wires.

CLAIMS

1. A VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, characterised in that modems on relatively short wires have control means for reducing their transmit power so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.
2. A VDSL system, as claimed in claim 1, characterised in that said relatively short wires are less than 1,000 metres long and said substantially longer wires are more than 1,000 metres long.
3. A VDSL system, as claimed in claim 1, or claim 2, characterised in that said control means are adapted to distribute power over an available frequency band so that said target bit rate is achieved.
4. A VDSL system, as claimed in any previous claim, characterised in that said system is adapted to modulate transmitted data using DMT.
5. A VDSL system, as claimed in any previous claim characterised in that the control means, associated with a given modem connected to a given wire, is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the FEXT transfer function for said given wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + F_{\text{ext}_k}) \Gamma_M} \right)$$

where F_{ext_k} is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the

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system margin and R is the target bit rate per DMT frame.

6. A VDSL system, as claimed in claim 5, characterised in that said FEXT transfer function is given by:

$$F_k = K |H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k, d is the length of the wire and K is a constant.

7. A VDSL system, as claimed in either claim 5, or 6, characterised in that E_k is always less than a maximal allowable PSD-level, PSD_{\max} , for said VDSL system.

8. A VDSL system, as claimed in claim 7, characterised in that:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

9. A modem for use with a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths, said modem having a target bit rate, characterised in that said modem has control means for reducing its transmit power so that FEXT produced by said modem is reduced.

10. A modem, as claimed in claim 9, characterised in that said control means is adapted to distribute power over an available frequency band so that said target bit rate is achieved.

11. A modem, as claimed in either claim 9, or 10, characterised in that said modem is adapted to modulate transmitted data using DMT.

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12. A modem, as claimed in any of claims 9 to 11, characterised in that said modem is connected to a wire, and in that said control means is adapted to produce an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the FEXT transfer function for said wire and λ is a constant, λ being adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + \text{Fext}_k) \Gamma_M} \right)$$

where Fext_k is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

13. A modem, as claimed in claim 12, characterised in that said FEXT transfer function is given by:

$$F_k = K |H_k|^2 f_k^2 d$$

where H_k is the transfer function for the given wire, f_k is the frequency for subcarrier k , d is the length of the wire and K is a constant.

14. A modem, as claimed in either claim 12, or 13, characterised in that E_k is always less than a maximal allowable PSD-level for VDSL.

15. A modem, as claimed in claim 14, characterised in that:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < \text{PSD}_{\max}$$

and

$$E_k = PSD_{\max} \quad \text{for } \lambda \frac{n_k}{F_k} \geq PSD_{\max}$$

16. In a VDSL transmission system having a plurality of modems operating on an access network in which at least some of said modems operate on wires of different lengths and in which there is a target bit rate for each modem, a method of performing power back-off, characterised by reducing the transmit power of modems on relatively short wires so that FEXT produced by said modems is reduced enabling modems on substantially longer wires to transmit at higher bit rates.

17. A method as claimed in claim 15, characterised by said relatively short wires being less than 1,000 metres long, and by said substantially longer wires being more than 1,000 metres long.

18. A method, as claimed in either claim 16, or claim 17, characterised by distributing power over an available frequency band so that said target bit rate is achieved.

19. A method, as claimed in any of claims 16, to 18, characterised by modulating transmitted data using DMT.

20. A method, as claimed in any of claims 15 to 19, characterised by producing an energy loading for the k^{th} sub-carrier given by:

$$E_k = \lambda \frac{n_k}{F_k}$$

where n_k is the background noise on sub-carrier k , F_k is the FEXT transfer function for said given wire and λ is a constant which is adjusted so that

$$R = \sum_{k=0}^{N-1} \log_2 \left(1 + \frac{E_k}{\Gamma(n_k + F_{\text{ext}_k}) \Gamma_M} \right)$$

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where $F_{ext,k}$ is the FEXT from other VDSL modems, Γ is the SNR - gap, Γ_m is the system margin and R is the target bit rate per DMT frame.

21. A method, as claimed in claim 20, characterised by said FEXT transfer function being given by:

$$F_k = K |H_k|^2 f_k^2 d$$

5 where H_k is the transfer function for the given wire, f_k is the frequency for sub-carrier k , d is the length of the wire and K is a constant.

22. A method, as claimed in either claim 20, or 21, characterised by E_k always being less than a maximal allowable PSD-level, PSD_{max} , for said VDSL system.

23. A method, as claimed in claim 22, characterised by:

$$E_k = \lambda \frac{n_k}{F_k} \quad \text{for} \quad \lambda \frac{n_k}{F_k} < PSD_{max}$$

and

$$E_k = PSD_{max} \quad \text{for} \quad \lambda \frac{n_k}{F_k} \geq PSD_{max}$$

ABSTRACT

Improvements in, or Relating to, VDSL Transmission Systems

One problem, frequently encountered with VDSL transmission systems, is that upstream FEXT produced by system users having short wires can be very strong. Users having shorter wires get high bit rates whereas users having longer wires get low bit rates. In extreme cases it may happen that users with wire lengths greater than 1000 metre cannot transmit data upstream. The present invention provides a VDSL transmission system with a plurality of modems. The modems are located at varying distances from a central station. There is a target bit rate for each modem. That modems on shorter wires have control means for reducing their transmit power. This reduces the FEXT produced by these modems enabling modems on longer wires to transmit at higher bit rates.

1/2

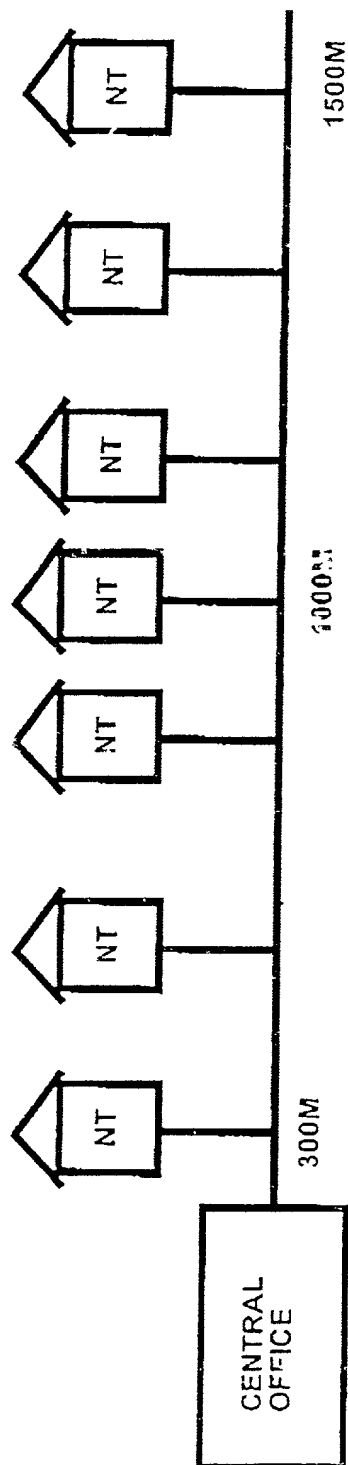


FIGURE 1

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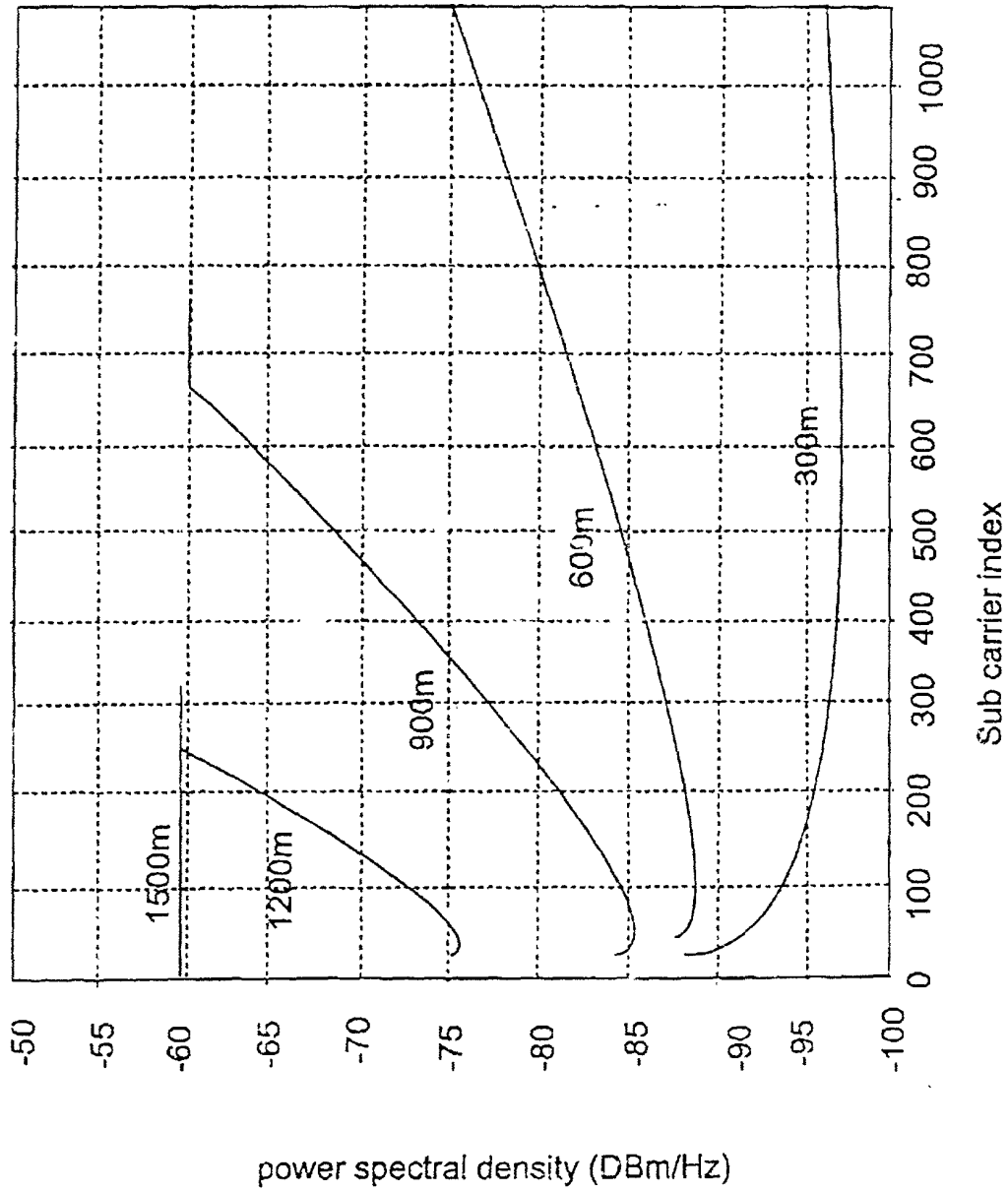


Fig 2

Declaration and Power of Attorney for Patent Application

Déclaration et Pouvoirs pour Demande de Brevet

French Language Declaration

En tant que l'inventeur nommé ci-après, je déclare par le présent acte que:

Mon domicile, mon adresse postale, et ma nationalité sont ceux figurant ci-dessous à côté de mon nom.

Je crois être le premier inventeur original et unique (si un seul nom est mentionné ci-dessous), ou l'un des premiers co-inventeurs originaux (si plusieurs noms sont mentionnés ci-dessous) de l'objet revendiqué, pour lequel une demande de brevet a été déposée concernant l'invention intitulée:

IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

et dont la description est fournie ci-joint, à moins que la case suivante n'ait été cochée:



a été déposée sous le
numéro de demande des Etats-Unis ou le numéro de
demande internationale



les spécifications portant le dossier de l'avocat
numéro _____

et modifiée le _____
(le cas échéant).

Je déclare par le présent acte avoir passé en revue et compris le contenu de la description ci-dessus, revendications comprises, telles que modifiées par toute modification dont il aura été fait référence ci-dessus.

Je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, §1.56 du Code fédéral des réglementations.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

IMPROVEMENTS IN, OR RELATING TO, VDSL TRANSMISSION SYSTEMS

the specification of which is attached hereto unless one of the following boxes is checked:



was filed on
as United States Application Number or International
Number



the specification of which bears attorney
docket No. _____

and was amended on _____
(if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

French Language Declaration

Je revendique par le présent acte avoir la priorité étrangère, en vertu du Titre 35, §119(a)-(d) ou § 365(b) du Code des Etats-Unis, sur toute demande étrangère de brevet ou certificat d'inventeur ou, en vertu du Titre 35, § 365(a) du même Code, sur toute demande internationale PCT désignant au moins un pays autre que les Etats-Unis et figurant ci-dessous et, en cochant la case, j'ai aussi indiqué ci-dessous toute demande étrangère de brevet, tout certificat d'inventeur ou toute demande internationale PCT ayant une date de dépôt précédant celle de la demande à propos de laquelle une priorité est revendiquée.

Prior foreign application(s)
Demande(s) de brevet antérieure(s)

PCT/SE99/02116

(Number)
(Numéro)

PCT

(Country)
(Pays)

9900788-2

(Number)
(Numéro)

SWEDEN

(Country)
(Pays)

9804021-5

(Number)
(Numéro)

SWEDEN

(Country)
(Pays)

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35 §119(e) du Code des Etats-Unis, de toute demande de brevet provisoire effectuée aux Etats-Unis et figurant ci-dessous.

(Application No.)
(N° de demande)

(Filing Date)
(Date de dépôt)

(Application No.)
(N° de demande)

(Filing Date)
(Date de dépôt)

Je revendique par le présent acte, le bénéfice, en vertu du Titre 35 § 120 du Code des Etats-Unis, de toute demande de brevet effectuée aux Etats-Unis, ou en vertu du Titre 35, § 365(c) du même Code, de toute demande internationale PCT désignant les Etats-Unis et figurant ci-dessous et, dans la mesure où l'objet de chacune des revendications de cette demande de brevet n'est pas divulgué dans la demande antérieure américaine ou internationale PCT, en vertu des dispositions du premier paragraphe du Titre 35, § 112 du Code des Etats-Unis, je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code Fédéral des réglementations, dont j'ai pu disposer entre la date de dépôt de la demande antérieure et la date de dépôt de la demande nationale ou internationale PCT de la présente demande.

(Application No.)
(N° de Demande)

(Filing Date)
(Date de Dépôt)

(Application No.)
(N° de Demande)

(Filing Date)
(Date de Dépôt)

Je déclare par le présent acte que toute déclaration ci-incluse est, à ma connaissance, véridique et que toute déclaration formulée à partir de renseignements ou de suppositions est tenue pour véridique; et de plus, que toutes ces déclarations ont été formulées en sachant que toute fausse déclaration volontaire ou son équivalent est passible d'une amende ou d'une incarcération, ou des deux, en vertu de la Section 1001 du Titre 18 du Code des Etats-Unis, et que de telles déclarations volontairement fausses risquent de compromettre la validité de la demande de brevet ou du brevet délivré à partir de celle-ci.

I hereby claim foreign priority under Title 35, United States Code, §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(e) of any PCT International application which designated at least one country other than the United States, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

Priority not claimed

Droit de priorité non revendiqué

18 NOVEMBER 1999

(Day/Month/Year Filed)
(Jour/Mois/Année de dépôt)

☐

5 MARCH 1999

(Day/Month/Year Filed)
(Jour/Mois/Année de dépôt)

☐

21 NOVEMBER 1998

(Day/Month/Year Filed)
(Jour/Mois/Année de dépôt)

☐

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or § 365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Status) (Patented, pending, abandoned)
(Statut) (breveté, en cours d'examen, abandonné)

(Status) (Patented, pending, abandoned)
(Statut) (breveté, en cours d'examen, abandonné)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

French Language Declaration

POUVOIR: En tant que l'inventeur ci-dessous, je désigne par la présente l'(les) avocat(s) et/ou agent(s) suivant(s) pour qu'il(s) poursuive(nt) la procédure de cette demande de brevet et tienne(nt) toute affaire s'y rapportant avec l'Office des brevets et des marques: (mentionner le nom et le numéro d'enregistrement)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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Adresse Postale		Post Office Address <u>Lingonstigen 30</u>
Nom complet de l'unique ou premier inventeur	400	Full name of sole or first inventor <u>BENGTSSON Daniel</u>
Signature de l'inventeur	Date	Inventor's signature <u>Daniel Bengtsson</u> Date: <u>2000-10-02</u>
Domicile		Residence <u>S-977 53 LULEÅ, SWEDEN</u> SEY
Nationalité		Citizenship <u>Swedish</u>
Adresse Postale		Post Office Address <u>Forskarvägen 36 A</u>
Nom complet du second co-inventeur, le cas échéant	500	Full name of second or joint inventor <u>ISAKSSON Mikael</u>
Signature de l'inventeur	Date	Inventor's signature <u>Mikael Isaksson</u> Date: <u>2000-10-02</u>
Domicile		Residence <u>S-973 42 LULEÅ, SWEDEN</u> SEY
Nationalité		Citizenship <u>Swedish</u>
Adresse Postale		Post Office Address <u>Borgmästarevägen 7</u>

French Language Declaration			
Nom complet de l'unique ou premier inventeur		Full name of sole or first inventor	
600		NORDSTRÖM Tomas	
Signature de l'inventeur	Date	Inventor's signature	Date
		Tomas Nordström	2000-10-11
Domicile		Reside at	
		S-977 53 LULEÅ, SWEDEN SEV	
Nationalité		Citizenship	
		Swedish	
Adresse Postale		Post Office Address	
		Pravitzvatnagen 3	
Nom complet du second co-inventeur, le cas échéant		Full name of second or joint inventor	
700		ÖDLING Per	
Signature de l'inventeur	Date	Inventor's signature	Date
		Per Ödling	2000-10-09
Domicile		Residence	
		S-977 51 LULEÅ, SWEDEN SEV	
Nationalité		Citizenship	
		Swedish	
Adresse Postale		Post Office Address	
		Professorsvägen 109 B	
Nom complet du second co-inventeur, le cas échéant		Full name of second or joint inventor	
800		BAHLENBERG Gunnar	
Signature de l'inventeur	Date	Inventor's signature	Date
		Gunnar Bahlenberg	2000-10-02
Domicile		Residence	
		S-976 32 LULEÅ, SWEDEN SEV	
Nationalité		Citizenship	
		Swedish	
Adresse Postale		Post Office Address	
		Blidvägen 234	

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French Language Declaration			
Nom complet du second co-inventeur, le cas échéant		Full name of second or joint inventor	
900		JOHANSSON Magnus	
Signature de l'inventeur	Date	Inventor's signature	Date
		Magnus Johansson	2000-10-02
Domicile		Residence	
		S-972 41 LULEÅ, SWEDEN SEV	
Nationalité		Citizenship	
		Swedish	
Adresse Postale		Post Office Address	
		Timmermansgatan 34	
Nom complet du second co-inventeur, le cas échéant		Full name of second or joint inventor	
1000		OLSSON Lennart	
Signature de l'inventeur	Date	Inventor's signature	Date
		Lennart Olsson	2000-10-02
Domicile		Residence	
		S-973 31 LULEÅ, SWEDEN SEV	
Nationalité		Citizenship	
		Swedish	
Adresse Postale		Post Office Address	
		Majvagen 39	
Nom complet du second co-inventeur, le cas échéant		Full name of second or joint inventor	
1100		ÖKVIST Sven-Göran	
Signature de l'inventeur	Date	Inventor's signature	Date
		Sven-Göran Ökvist	2000-10-02
Domicile		Residence	
		S-974 41 LULEÅ, SWEDEN SEV	
Nationalité		Citizenship	
		Swedish	
Adresse Postale		Post Office Address	
		Hagaplan 7	